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A field study of the social behavior of Goeldi's monkeys (*Callimico goeldii*) in North Bolivia

I. Group composition, breeding cycle, and infant development

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ABSTRACT A group of *Callimico* was artificially baited in North Bolivia. After all of group members were identified completely, systematic observation of social behaviors was conducted. During the investigation, two infants were observed in the course of development for their first three months of life. The chronology of their growth is made. Females *Callimico* are polyoestrous. They can be pregnant twice a year. There are two fertile females in the group. After 10 days of giving birth to an infant, copulation occurs. The gestation period ranges 150–180 days. The infants solely cling to their own mother for first 10 days of life, and then begin to receive the non-mothers' care till they get independence at the age of 7 weeks. Infant- and food-transferring behaviors are performed by every group member. The frequencies of these behaviors show the highest level when the infants are 4–5 weeks old. Effects of the delivery of the infants and their development on group organization are discussed in terms of the function of species-specific care-taking behaviors.

INTRODUCTION

Field researches on New World primates have revealed that it is very difficult to find out the locality in which *Callimico* inhabits. Summarizing up the preceding available reports concerning the observation of wild *Callimico* and personal information given to him, IZAWA (1979) considers that *Callimico* has a low population and scattered distribution. He discusses that this peculiar pattern of distribution is not induced by human influences such as strong hunting pressures, but as a result of decrease in the habitat in which *Callimico* adapts to live and of competitive relationships between *Callimico* and other species. The phylogenetic inter-specific relations in New World primates are supposed to reflect in the specificity found in the distribution of *Callimico*.

This assumption indicates that field research of *Callimico* is urgent in order to discuss the process of speciation of platyrrhini. In terms of comparison of the ecology and behavior of *Callimico* with those of other New World primates, the validity of theories concerning the phylogeny of platyrrhini is to be discussed. The aim of this study is to investigate behavior of wild *Callimico* inhabiting in Bolivia and to make some contributions to the attempt to understand the evolution of New World primates.

PROCEDURE OF FEEDING AND OBSERVATION

When the research site, Mucden, Pando in Bolivia, was first visited on July 12, three male *Callimicos* were found to be raised by a native inhabitant. For the conservation of *Callimico*, it was thought to be the best to send them back to the group, out of which they had been captured. Once any individual was experienced to be in captivity, however, it seemed so diffi-

Table 1. Days and hours of monthly observations in the feeding site.

	July	Aug.	Sep.	Oct.	Nov.	Dec.
Days of observation	8	26	10	19	24	13
Hours of observation	9	91	8	19	34	10

cult for him to be accepted by their group members again that routine short term contact was attempted between the captive individuals in the small cages and those of free-living.

Each of three transportational cages, containing a captive male, was hung day and night on the tree which was supposed to locate in the midst of the home range of the native group of *Callimico*. As long as *Callimico* was not observed around the cages, their locations were changed tentatively. More than 10 bunches of bananas were fixed on the trunks of the trees near by cages.

On July 20 and 21, bananas were found to be eaten with marked tracts of teeth which indicated that any kind of small-sized primates came. The next day, the shelter for observation was built, shielded with leaves of a kind of palmito tree, 8.5 m apart from the cage. In the morning of July 24, four *S. fuscicollis* and a *Callimico* were observed. Since then, a group of *S. fuscicollis* consisted of six individuals (3 males and 3 females) and that of *Callimico* came to eat bananas. Individual identification of two groups' members was completed by the end of July.

On August 12, a feeding table (2.5 m × 4.0 m) made from wood was located at the height of 1.4 m at the center of the feeding site. Systematic observation on the intragroup relationship began. Till December 27 in 1979, total of 171 hours (100 days) of observation on the group of *Callimico* was made at the feeding site (Table 1), while 34 hours in other situations.

RESULTS

Group composition and its change during investigation

Except for the three captured males, the group was consisted of two males and four females when it was fed first (Table 2). Like in any field surveys, it was difficult to determine the age of every individual of this group. Only a male (named "Ricardo") was supposed to be sexually matured, however, whilst there were two full adult females in the group (named "Margarita", "Elena", respectively). Ricardo was larger than other two females and conspicuous in his unpigmented fur around the neck and hindquarters. Although these facts might suggest that he was the oldest in the group, there is a possibility that its morphological differences were due to the sexual dimorphism in *Callimico*.

Table 2. Group composition on August 1st.

Fulladults		
Ricardo	Male	
Margarita	Female	
Elena	Female	
Juveniles and infants		
Anna	Female	3 or 4 yrs. (estimated)
Christóbal	Male	3 yrs. (estimated)
Arturo	Male	2 yrs. (estimated)
Juana	Female	1 yr.
Chico	Male	2 or 3 months.
Dante	Male	2 or 3 months.

The observation of *Callimico* in captivity indicated that newborn infants were characteristic in their long blackish hair around the cheeks and forehead for their first year. Though, at age of two, the pelage of forehead and testes developed as in adults, brownish fur still remained for another year or more a few.

By reference to these features and body size, another male was considered to be two years old (named "Atruro"). Out of other two females, one was to be three or four years (named "Anna"), intermediate in body size between Elena and Arturo, and another was evidently born last year (named "Juana"). Among three males in captivity, one, as large as Anna, but less blackish than adults, was estimated to be three years old (named "Christóbal"). Other two males were to be just two months (named "Chico" and "Dante"). Both of them attained 350 g when they were measured in October and November, respectively, which suggested that they were born in April or May on the basis of the chronology of growth by Lorenz & Heinemann (1967).

On August 1, when the whole group came to the feeding site, a captive male, Christóbal, was released into it. Chico and Dante were released on October 6, and December 5, respectively. All of them were accepted by the group members and had been observed till the completion of this research.

Margarita was seen to carry a new-born infant in the morning on September 25. Twelve days later, another neonate was also found to cling to Elena on October 7. Both of them could be observed until the investigation terminated. Since November 16, on the other hand, a female, Anna, came to disappear in the group and never be seen.

Breeding cycle

(1) Group in Mucden

Both Margarita and Elena visited the feeding site without neonates the day before September 5 and October 7 respectively in the afternoon, while each of the infants was observed first in the morning of the next day. After their deliveries, Ricardo tended to attempt bodily contact with each female. From September 28 through October 4, long-lasting side-by-side or ventral-dorsal contact, which has never been seen on other occasions, occurred between Ricardo and Margarita, and between Ricardo and Elena on October 9, 11 and 13. Accumulative duration of contact occupied more than 60% of total time of observation in each pair. When females entered or left the feeding site, Ricardo always followed them, and inspected their genital area frequently. On October 9, Ricardo was observed to copulate with Elena with her infant in the back. While she was clinging vertically to a tree at the height of about 2.5 m, Ricardo mounted her with serial thrusts. This mounting lasted about 35 seconds and appeared to be completed with his ejaculation. The identical mounting behavior with thrusts was also observed between Ricardo and Margarita on October 4, though it resulted in her immediate avoidance.

After these periods of high proximity in each pair, they tended to space out as before. Passive contact was rarely seen.

(2) Other groups

In order to study the breeding cycle of other *Callimico* groups, short-term surveys were conducted twice from June 18 through 30, and December 14 to 17 in 1979 in Triumpho, 20 km apart from Mucden, where other two groups of *Callimico* inhabited, which were studied by Pook & Pook (1979) for 74 days (from August through November) in 1978. They report that

one group was consisted of 9 individuals, containing a neonate, in November in 1978, and that 4 individuals were seen in another group. Both of two groups could be found in 1979 by the author. Although the latter group was still made up of 4 individuals in June, two infants were newly observed in December. They were supposed to be born from the end of August through September on the basis of the information on the native inhabitants and body size. On the other hand, 9 animals were counted out in the former group. It contained, however, a neonate and an infant of 6 or 7 months of age. Therefore, two group members were estimated to have disappeared from the group within a year from November in 1978.

* Group in captivity

For reference of the field observation, a captive group of *Callimico* consisted of a pair of adult male and female, and their infants was observed in Japan Monkey Centre from July in 1977 through May in 1980. Adult individuals were captured in the upper Amazon basin in Pando, Bolivia, where this investigation was conducted, and sent to Japan in 1973.

On October 26 in 1977, a prematured infant was born though it had already died when a zoo keeper found it. On March 30 in 1978, a male baby was given birth. Then, 3 female infants were born on October 6 in 1979, March 30, and October 12 in 1979 successively. The intervals between two successive births were 190, 175, and 196 days, respectively.

After the birth of the first male infant, the adult male frequently approached and groomed the baby. On April 4, however, a sharp decrease of frequencies of contact between them occurred suddenly, while the adult male began to follow the adult female. On April 5, copulation was observed, preceded and followed by long-lasting grooming and genital inspection. Since then, high proximate relations between the adult male and female was seen till April 16.

The similar relationship also occurred 6 days after the birth of the next baby, from October 12 to October 19. Copulation was seen, too, on October 15.

Infant development

First two weeks after giving birth, infants spent most of time by clinging solely to each of their mothers on the back. The behavior pattern of clinging was identical with that of cebids, and callithricids. They scarcely reacted to environmental stimuli. Only when they suckled mother's nipple, they moved a little, and clinged to her ventrum over the shoulder by the upside-down position, orienting their head downward. On any occasion, mothers did not groom their infants, though they supported infant's back with their hands when infants suckled. Although other group members, among others, Ricardo, another adult female, and Juana appeared to be interested in the infants and attempted to touch them, mothers were likely to withdraw.

This first stage of infant development was terminated by maternal rejection (Fig. 1). On October 11 and 20, respectively, Margarita and Elena were observed to try to get rid of their own infant's clinging suddenly by rubbing and pressing it on the tree, pulling with their hands, and sometimes trying to bite a little, to which the babies screamed and resisted. This interaction immediately induced other individuals, keeping proximity with Margarita or Elena at that time to approach and transport the infant instead of its mother. As pointed out by Figure 2, which indicates the percent of time when the infants clinged to the mother and others out of total time of observation, the infants came to be less likely to keep contact with their mother at age of three weeks, and spent more time with non-mothers when they were four weeks. As shown by bi-modal peak in Figure 3, aggressive behavior was not seen often by non-mothers in this stage. Maternal rejection was performed continually for several days during which, the infants tended to cling to their mother in any time she was in proximate with them,

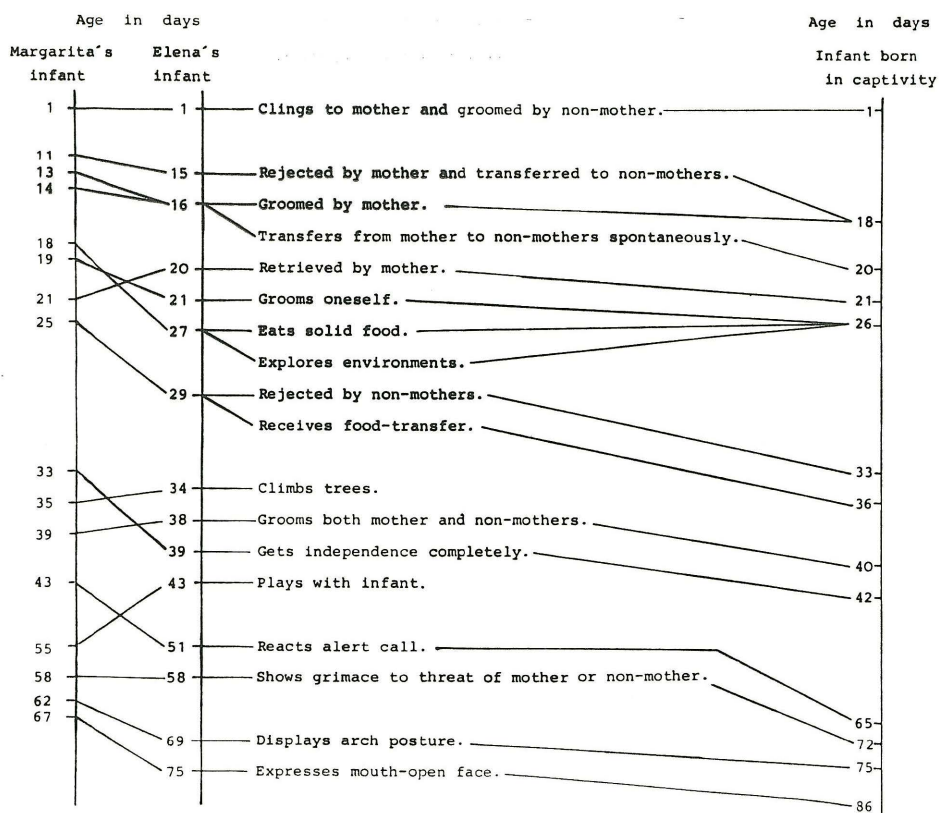


Fig. 1 Chronology of infant development.

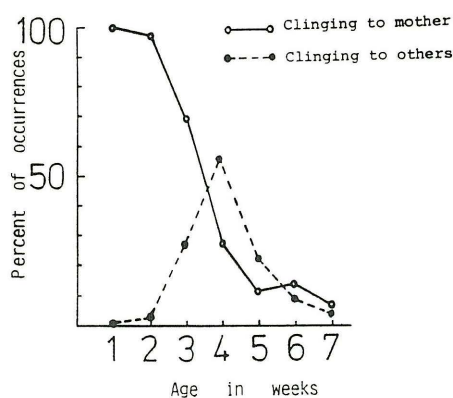


Fig. 2 Percent of occurrences of infant clinging to mother and non-mothers as a function of infant age in weeks.

though the rejection was less likely to occur as the infants accustomed themselves to cares of non-mothers.

Frequencies of spontaneous transferring of infants from carers, which was observed for the first time after a few days of the first occurrence of maternal rejection, increased gradually,

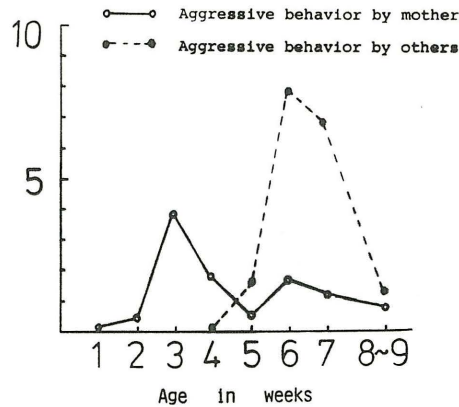


Fig. 3 Mean number of occurrences per hour of aggressive behaviors performed by mother and non-mother to the infants as a function of infant age in weeks.

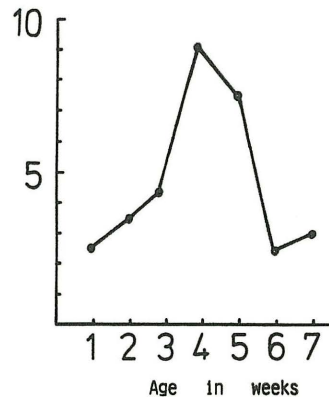


Fig. 4 Mean number of occurrences per hour of grooming performed by the group members to the infants as a function of infant age in weeks.

which elicited the mothers to restrain their own infants. Infants' locomotor ability was still far from being mature, and sometimes they were retrieved from falling down from trees. Any strange object was begun to be manipulated and explored by licking, sniffing, and touching. At the identical period, the infants were observed to eat bananas at the feeding site by themselves.

When infants were four weeks old, occurrences of grooming attained the highest level (Fig. 4). Females participated in it much more than males. The former performed grooming approximately three times as often as the latter did. But, after the ultimate increase at four weeks, the frequency began to show a decrease till six weeks, when its rate was as low as that of first week. It was due to that non-mothers were reluctant to participate in grooming interactions.

A similar trend can be found in the occurrence of infant transferring. This behavior was scored each time when an individual took the infant from the another one. Usually a receiver approached a tender with the side-by-side position, and inserted his hands between the infant and tender, or touched slightly them. Although there was not an infant-transferring during

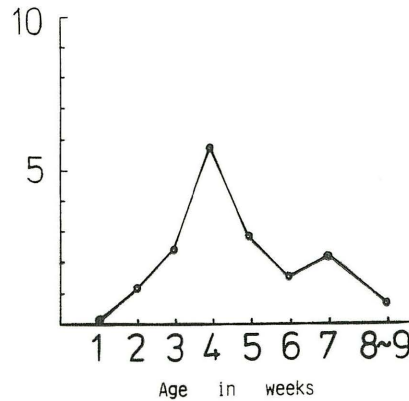


Fig. 5 Mean number of occurrences per hour of infant-transferring as a function of infant age in weeks.

the first week of infants' age, its occurrences increased correlatively with those of grooming at age of two weeks. As shown by Figure 5, a decrease was noted between four and five weeks markedly.

In reverse, a sharp increase was found in the performance of aggressive behavior to infants by non-mothers from five to six weeks, when they began to show reluctance to take care of infants. The agonistic behavior similar to that performed by the mother before, was observed. When the infants attempted to cling to their mother, rejected by others, aggressivity was expressed by her, too. Therefore, level of antagonistic interactions by mother showed increase again in six weeks (Fig. 3). Compared with other individuals, non-mother adult females and Juana, who were more likely to groom the infants than others, tended to less often participate in this kind of interactions.

As indicated by Figure 6, the degree of independence of infants was accelerated by the rejection of non-mothers in five weeks. From 33 to 39 days of age, infants got independence completely, except for the case of emergency, for instance, when alert call was vocalized. Their locomotor ability fully developed. They did not appear to feel any difficulties in leaping or jumping among trees, and could approach, follow, or leave other group members freely when they wished. In this period, grooming was observed for the first time to be performed by them.

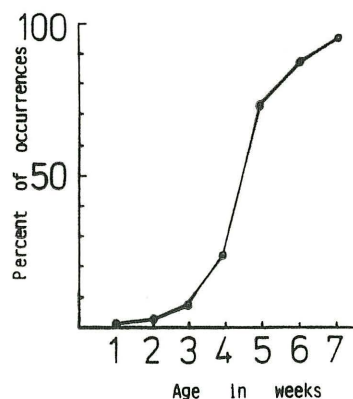


Fig. 6 Percent of getting independence of the infants as a function of infant age in weeks.

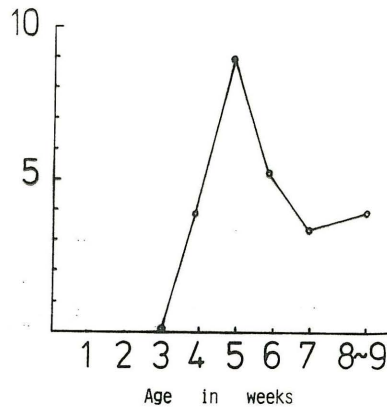


Fig. 7 Mean number of occurrences of food-transferring per hour as a function of infant age in weeks.

In interactions participated by infants, food-transferring behavior was seen (Fig. 7). When an individual was eating bananas in the feeding site, an infant approached him, extended and inserted the hand between the food and the tender. Although the food was transferred to the infants without rejection on some occasions, the transfer was accompanied by some resistance by the possessor, if it succeeded, when he turned away and showed his rear to the infants. In extreme cases, the possessor clutched and threatened infants with an open mouth. This behavior came to be seen after several days when infants began to eat solid food. Then, it showed similar trend to infant-transferring and grooming. Even after the complete independence of infants, food-transferring was still observed frequently.

When Margarita's infant was 43 days old and Elena's was 55 days old, physical contact was seen between them for the first time. In seven and eight weeks, ventro-ventral embracing or clasping was often observed. An infant held another's arm, leg, or face, and pulled it. They were likely to sit, facing side to side. Then, an infant moved toward another's rear and clinged to it. At age of nine weeks, rough-and-tumble behavior became to be dominant to other patterns of interactions. Complex behavioral sequences, which included chasing and the pattern like hide-and-seek, developed. Facial expressions came to be observed. Their behavioral repertoires were almost identical with those of adults. Margarita's infant, senior to Elena's one, was likely to express arch posture and mouth-open face, while the latter tended to display grimace. In rough-and-tumble play, mounting of the latter by the former occurred more often than the opposite relations. When the latter screamed, however, Elena or other adult males sometimes chased the former away.

Except for the interaction with each other, the infants kept contact and spent more time with Chico, Dante, and Juana than with their own mother. These five individuals were almost always observed to feed together at the feeding site in November and December. The latter three individuals were tolerant to the agonistic behavior of the infants, who attempted play-like biting. Punishing occurred rarely, while other non-mothers reacted in the identical way as did with each other, if rough play behavior was performed.

In other situations, for instance, during the group progression or foraging, infants and juveniles also tended to keep proximity with each other than with other individuals. The fact that Ricardo and Christobal, among others, appeared to be avoided by the infants most frequently was suggested by the highest level of the spacing tendency by the latter to the former.

DISCUSSION

The fact that Margarita and Elena gave birth at the end of September, and the first week of October, respectively, and that the two infants who were captured in June had been born in April or May indicate that the distinct birth season exists in *Callimico* twice a year. Each of these periods is considered to be corresponding to the critical one when the dry season passes into, or is replaced by the rainy season, because the latter season usually begins in October or November and lasts by the next March or April in North Bolivia.

Chico and Dante tended to keep proximity, respectively, with Margarita and Elena more often than with other individuals when they were released into the group. Chico vocalized infantile begging call only to Margarita, which elicited care-taking behaviors. The same applied between Dante and Elena. In captivity, Chico and Dante attempted to escape from their cages only when Margarita and Elena, respectively, approached. Evidently, Chico is considered to have been given birth by Margarita, and Dante is by Elena. Considering that there were solely two fertile females in the group investigated, it is concluded that *Callimico* females are polyoestrous and can be pregnant twice a year. As supported by the short-term survey on other *Callimico* groups, there can be more than one fertile female in a group. After the delivery, these females became in estrous, and copulation occurred. The gestation period is estimated as 150–180 days.

The occurrence of maternal rejection, which brought to an end of the first stage of infant development when infants clinged solely to their mothers, is supposed to correlate with the termination of intimate sexual relations between an adult male and female. The female might become pregnant in this period. Her endocrinological change may take part in her behavioral changes. At the second stage, non-mothers also participated in the care of infants. Infant-transfer and food-transfer were observed. The group became more cohesive than in other periods. Mothers are much handicapped in mobility when babies are clinging, which may make easy for predator animals to attack them. Infants have to experience social contact with other group members in order to socialize in their development as well as to learn other skills, not only in safety, but also rapidly as possible. These factors might correlate with the occurrences of food-transfer and infant-transfer, which then make the group very cohesive. Maternal rejection functions in order to facilitate infants' independence. This behavior, however, may be always performed at the cost of allowing some possibilities of infants' mortality, which is compensated by the care-taking behaviors of non-mothers.

After full development of infant's locomotor ability, they are considered to come along well without specific protection by others. A more complicated social relations than before were found among infants and their siblings. This relationship is supposed to accelerate infants' socialization, while their mothers are ready to deliver of neonates again. Therefore, the breeding and infant development make the annual cycle geared to seasonal changes in rainfall, which is considered to be a kind of effective strategies for reproduction of a species.

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